

TITLE

**FIELD EMISSION DISPLAY AND METHOD OF
MANUFACTURING THE SAME**

CLAIM OF PRIORITY

5 [0001] This application claims priority under 35 U.S.C. § 119 on an application entitled “*FIELD*
6 *EMISSION DISPLAY AND METHOD OF MANUFACTURING THE SAME*”, filed in the Korean
7 Intellectual Property Office on 21 January 2003 and assigned Serial No. 2003-3982, the contents
8 of which are hereby incorporated by reference and on an application filed in the Korean Intellectual
9 Property Office on 2 July 2003 and assigned Serial No. 2003-44534, the contents of which are also
10 hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a field emission display and a method of manufacturing the same, and more particularly to a field emission display including a mesh grid and a focusing electrode and a method of manufacturing the same.

Description of the Related Art

[0003] Field emission displays (FEDs) are devices comprised of a front substrate and a rear substrate forming a vacuum chamber. The front substrate includes an anode and a phosphor on

1 the inside thereof. The rear substrate includes a cathode and an emitter on the inside thereof.
2 Electrons emitted from the emitter are directed toward the anode and then excite the phosphor,
3 thereby emitting predetermined light. Field emission displays can be used in automobile
4 dashboards.

5 **SUMMARY OF THE INVENTION**

6 [0004] The present invention provides an improved field emission display.

7 [0005] The present invention also provides a field emission display capable of preventing
8 arc-discharge even when a high voltage is applied.

9 [0006] The present invention also provides a method of manufacturing a field emission display
10 capable of preventing arc-discharge even when a high voltage is applied.

11 [0007] According to an aspect of the present invention, there is provided a field emission display
12 comprising: a first substrate; an electron emission assembly arranged on said first substrate; a
13 second substrate arranged a predetermined distance from said first substrate, said first and second
14 substrates forming a vacuum space; an illumination assembly arranged on said second substrate,
15 said illumination assembly being illuminated by electrons emitted from said electron emission
16 assembly; and a mesh grid arranged above said electron emission assembly.

17 [0008] According to another aspect of the present invention, said mesh grid comprises a metal.

18 [0009] According to another aspect of the present invention, said mesh grid comprises one of
19 stainless steel, invar, and an iron-nickel alloy.

20 [0010] According to another aspect of the present invention, the iron-nickel alloy comprises 2.0

1 to 10.0 wt% of Cr.

2 [0011] According to another aspect of the present invention, the iron-nickel alloy comprises
3 40.0 to 44.0 wt% of Ni.

4 [0012] According to another aspect of the present invention, the iron-nickel alloy comprises 0.2
5 to 0.4 wt% of Mn, 0.7 wt% or less of C, and 0.3 wt% or less of Si.

6 [0013] According to another aspect of the present invention, the thermal expansion coefficient
7 of said mesh grid is in the range of $9.0 \times 10^{-6}/^{\circ}\text{C}$ to $10.0 \times 10^{-6}/^{\circ}\text{C}$.

8 [0014] According to another aspect of the present invention, electron emission assembly
9 comprises a cathode, a gate, and an electron emission source.

10 [0015] According to another aspect of the present invention, the gate is arranged on the upper
11 side of the cathode.

12 [0016] According to another aspect of the present invention, the gate is arranged on the lower
13 side of the cathode.

14 [0017] According to another aspect of the present invention, an intermediate material is arranged
15 between said electron emission assembly and said mesh grid.

16 [0018] According to another aspect of the present invention, said intermediate material
17 comprises an insulating material.

18 [0019] According to another aspect of the present invention, wherein said intermediate material
19 comprises a resistive material.

20 [0020] According to another aspect of the invention, wherein a focusing electrode is further
21 arranged on the mesh grid.

1 [0021] According to another aspect of the present invention, there is provided a field emission
2 display, comprising: a first substrate; an electron emission assembly arranged on said first
3 substrate; a second substrate arranged at a predetermined distance from said first substrate, said
4 first and second substrates forming a vacuum assembly; and an illumination assembly arranged on
5 said second substrate, said illumination assembly being illuminated by electrons emitted from said
6 electron emission assembly; and a mesh grid arranged above said electron emission assembly;
7 wherein said mesh grid is bonded to said electron emission assembly by a frit.

8 [0022] According to another aspect of the present invention, there is provided a method of
9 manufacturing a field emission display, the method comprising: providing a first substrate;
10 arranging an electron emission assembly on said first substrate; arranging a second substrate a
11 predetermined distance from said first substrate to form a vacuum space with said first and second
12 substrates; arranging an illumination assembly on said second substrate, and illuminating said
13 illumination assembly with electrons emitted from said electron emission assembly; and arranging
14 a mesh grid above said electron emission assembly.

15 [0023] According to another aspect of the present invention, there is provided a method of
16 manufacturing a field emission display device, the method comprising: providing a first substrate;
17 arranging an electron emission assembly on said first substrate; arranging a second substrate a
18 predetermined distance from said first substrate to form a vacuum assembly with said first and
19 second substrates; arranging an illumination assembly on said second substrate and illuminating
20 said illumination assembly with electrons emitted from said electron emission assembly; arranging
21 a mesh grid above said electron emission assembly; and bonding said mesh grid to said electron

1 emission assembly with a frit.

2 **BRIEF DESCRIPTION OF THE DRAWINGS**

3 **[0024]** A more complete appreciation of the invention, and many of the attendant advantages
4 thereof, will be readily apparent as the same becomes better understood by reference to the
5 following detailed description when considered in conjunction with the accompanying drawings
6 in which like reference symbols indicate the same or similar components, wherein:

7 **[0025]** FIG. 1 is a schematic sectional view of a conventional field emission display;

8 **[0026]** FIG. 2 is a schematic sectional view of another conventional field emission display;

9 **[0027]** FIG. 3 is a partial perspective view of the field emission display of FIG. 2;

10 **[0028]** FIG. 4 is a schematic sectional view of a field emission display according to an
11 embodiment of the present invention;

12 **[0029]** FIG. 5 is a partial perspective view of a mesh grid of the field emission display of FIG.
13 4;

14 **[0030]** FIG. 6 is a partial perspective view that illustrates the insertion of a spacer in the field
15 emission display of FIG. 4;

16 **[0031]** FIG. 7 is a flowchart of a process of manufacturing a field emission display according
17 to an embodiment of the present invention; and

18 **[0032]** FIG. 8 is a schematic sectional view of a field emission display according to another
19 embodiment of the present invention.

1 **DETAILED DESCRIPTION OF THE INVENTION**

2 **[0033]** FIG. 1 is a schematic sectional view of a conventional field emission display.

3 **[0034]** Referring to FIG. 1, a conventional field emission display essentially includes a front
4 substrate 5 and a rear substrate 1, which are spaced a predetermined gap apart by a spacer 8
5 interposed therebetween. The rear substrate 1 has a stacked structure including a cathode 2, an
6 insulator 3, and a gate 4 on the inside thereof. Holes are formed in the insulator 3 on the cathode
7 2, and microtip emitters 2' for electron emission are formed on the cathode 2 exposed through the
8 holes. Openings 4' corresponding to the holes are formed in the gate pattern to allows for the
9 attraction of electrons emitted from the emitters 2' toward an anode 6. The front substrate 5
10 includes the anode 6 on the inside thereof opposite to the rear substrate. A phosphor 7 is coated
11 on the anode 6. The anode 6 can be formed either in a strip pattern or as a single unit to cover the
12 whole inner surface of the front substrate. In such a display structure, the electrons emitted from
13 the emitters 2' excite the phosphor 7, thereby emitting light.

14 **[0035]** During the electron emission, arc-discharge can be caused in a space defined between
15 the two substrates. Although an exact cause of the arc-discharge is not known, it is believed that
16 the arc-discharge is caused by a discharge phenomenon through immediate ionization (avalanche
17 phenomena) of a large number of gases when the gases generated inside the panel are outgassed.

18 **[0036]** Arc-discharge can cause a short circuit between the anode and the gate. Therefore, a
19 high voltage is applied to the gate, thereby causing damage to the gate oxide and resistive layer.
20 This phenomenon becomes worse with increasing anode voltage. In particular, arc-discharge is
21 more easily caused by application of an anode voltage of more than 1 kV. Therefore, it is

1 impossible to obtain a high luminance field emission display stably driving at a high voltage in a
2 conventional field emission display having a simple support structure of a cathode and an anode
3 separated by a spacer.

4 [0037] FIG. 2 shows a field emission display disclosed in Korean Patent Application No.
5 2001-0081496 arranged to prevent the above-described arc-discharge.

6 [0038] Referring to FIG. 2, like in FIG. 1, a field emission display includes a front substrate 15
7 and a rear substrate 11, a spacer 18 interposed between the two substrates, a strip-patterned
8 cathode 12, an insulator 13, a strip-patterned gate 14, and emitters 12' exposed through holes
9 formed in the insulator 13. The front substrate 15 includes an anode 16 and a phosphor 17 on the
10 inside thereof. As mentioned above, the anode 16 can be formed either in a strip pattern, or as a
11 single layer pattern formed over the whole inner surface of the front substrate.

12 [0039] The field emission display further includes as arcing prevention means comprising a
13 mesh grid 19 formed between the gate and the anode to control electrons emitted from the emitters
14 12'.

15 [0040] In such a field emission display structure, even when a voltage of -100 to 300 V is
16 applied, an electric field at the gate edges decreases, thereby preventing arc-discharge.
17 Furthermore, even when arcing is caused, arc ions are trapped in the mesh grid prior to causing
18 damage to the cathode and then flow through a ground outlet, thereby preventing mechanical and
19 electrical damages.

20 [0041] FIG. 3 is a schematic sectional view that illustrates a process of forming the mesh grid
21 of FIG. 2.

1 [0042] Referring to FIG. 3, a mesh grid 19 is installed adjacent to a front substrate 15. A spacer
2 28 serves to maintain a gap between the mesh grid 19 and the front substrate 15. Protrusions of
3 the spacer 28 are inserted into through-holes formed in the mesh grid 19. A glass holder 23 serves
4 to support both ends of the spacer 28. An electrode 22 and the mesh grid 19 are interconnected
5 through a conductive paste 24. Therefore, a voltage can be applied to the electrode 22 and the
6 mesh grid 19.

7 [0043] In the field emission display described with reference to FIGS. 2 and 3, a mesh grid is
8 aligned with respect to an anode of a front substrate and fixed in position through firing. The
9 resultant structure thus obtained is then aligned with respect to a cathode of the rear substrate.
10 However, due to the difference in thermal expansion coefficient between metal and glass materials
11 during the firing process, it is difficult to perform an appropriate alignment between the mesh grid
12 and the cathode of the rear substrate. Therefore, electrons emitted from the emitters collide with
13 a phosphor adjacent to a desired emission region, thereby decreasing color purity. Also, when a
14 pulse voltage and a DC voltage are respectively applied to the gate electrode and the mesh grid,
15 a noise phenomenon due to vibration of the mesh grid can be caused in a display structure in which
16 only the edges of the mesh grid are fixed by the spacer.

17 [0044] Hereinafter, a field emission display including a mesh grid and a method of
18 manufacturing the same according to embodiments of the present invention will be described in
19 detail with reference to the accompanying drawings.

20 [0045] FIG. 4 is a schematic sectional view of a field emission display according to an
21 embodiment of the present invention.

1 [0046] Referring to FIG. 4, a field emission display according to this embodiment has a joined
2 structure of a front substrate 41 and a rear substrate 42, which are separated from each other by a
3 predetermined gap, and thus, a vacuum space is formed between the two substrates. A spacer 43
4 is installed to maintain the gap between the front substrate 41 and the rear substrate 42. A cathode
5 55 is formed on the inside of the rear substrate 42. An insulator 45 is formed on the cathode 55.
6 The insulator 45 has holes therein. Emitters 46 serving as an electron emission source are exposed
7 through the holes.

8 [0047] A gate 47 is formed on the insulator 45. The gate 47 has openings corresponding to the
9 holes of the insulator 45 to allow for attraction of electrons emitted from the emitters 46 toward
10 an anode 53. The cathode 55, the emitter and the gate 47 serve as an electron emission assembly.
11 In the illustrated embodiment, it is appreciated that the gate 46 is disposed on the upper side of the
12 cathode 55.

13 [0048] On the other hand, in another embodiment not shown in the drawings, the gate is
14 disposed on the lower side of the cathode. In this case, insulation between the gate and the cathode
15 55 must be ensured. However, there is no need to form openings in the gate. An example of a
16 field emission display having a gate formed on the lower side of a cathode is disclosed in Korean
17 Patent Application No. 2002-16804.

18 [0049] The front substrate 41 includes the anode 53 on the inside thereof. The anode 53 can
19 be formed either in a strip pattern or as a single layer formed over the whole inner surface of the front
20 substrate 41. When the anode 53 is formed in a strip pattern, the cathode 55 and the anode 53
21 intersect each other perpendicularly as viewed from top. A phosphor 54 is coated on the anode 53.

1 The phosphor 54 can be red, green, or blue.

2 [0050] A mesh grid 50 is formed between the gate 47 and the anode 53 to control electrons
3 emitted from the emitters 46. The mesh grid 50 is disposed on the gate 47. That is, the mesh grid
4 50 includes lower and upper insulators 49 and 51, which are respectively formed on lower and
5 upper surfaces of the mesh grid 50, and then the mesh grid 50 is disposed on the gate 47. The
6 lower insulator 49 can be replaced with a resistive layer comprising of a resistive material. Further,
7 both the lower and upper insulators 49 and 50 are replaced with the resistive layer. As shown in
8 the drawing, the mesh grid 50 is fixed in such a way that it is bonded to the gate 47 by a frit. The
9 mesh grid 50 serves to block the action of the electric field of the anode 53 on the electron
10 emission of the cathode 55 and to accelerate the emitted electrons. In another embodiment (not
11 shown) in which the cathode is disposed on the upper side of the gate, the mesh grid is disposed
12 upper side of the cathode.

13 [0051] A focusing electrode 52 is formed on the upper insulator 51, which is in turn formed on
14 the upper surface of the mesh grid 50. The focusing electrode 52 serves to enhance the focusing
15 performance of electron beam. That is, the focusing electrode 52 prevents the dispersion of
16 electrons accelerated by the mesh grid 50 and focuses the accelerated electrons on the anode 53
17 of interest for collision of them with the anode 53.

18 [0052] FIG. 5 is a schematic exploded perspective view that illustrates an arrangement of the
19 mesh grid 50 and the focusing electrode 52.

20 [0053] Referring to FIG. 5, the upper and lower insulators 51 and 49 are respectively formed
21 on the upper and lower surfaces of the mesh grid 50. The frit 48 is disposed on the lower surface

1 of the lower insulator 49 and the focusing electrode 52 is disposed on the upper surface of the
2 upper insulator 51.

3 [0054] The mesh grid 50 is formed in a mesh shape and made of stainless steel or invar or SUS.
4 Since invar and SUS have the thermal expansion coefficient smaller than normal stainless steel,
5 it is advantageous in decreasing a thermal stress generated during a firing process. The mesh grid
6 50 can also be made of an iron-nickel alloy. Since the iron-nickel alloy has the thermal expansion
7 coefficient much smaller than normal stainless steel, it is very advantageous in decreasing a
8 thermal stress generated during a firing process. Further, since the iron-nickel alloy has the
9 thermal expansion coefficient similar to glass, when the mesh grid made of the iron-nickel alloy
10 is fixed to the rear substrate, the thermal expansion coefficient of the mesh grid advantageously
11 affects the alignment with the cathode.

12 [0055] Meanwhile, openings 56 are formed in the mesh grid 50. Each of the openings 56
13 corresponds to one of red, blue, and green phosphors that make one pixel. That is, as shown in
14 FIG. 4, each of the openings 56 corresponds to only one phosphor 54. In detail, the openings 56
15 are formed correspondingly to intersections of the cathode 55 and the anode 53. Electrons emitted
16 from the emitters 46 pass through the openings 56.

17 [0056] The lower and upper insulators 49 and 51 are respectively formed on the lower and upper
18 surfaces of the mesh grid 50 in such a way not to be overlapped with the openings 56, as shown
19 in FIG. 5. As illustrated in FIG. 5, the upper and lower insulators 49 and 51 have openings. The
20 openings are extended in the longitudinal direction of the cathode 55. The focusing electrode 52
21 is formed on the upper surface of the upper insulator 51 in the same shape as the upper insulator

1 51. The frit 48 is formed on the lower surface of the lower insulator 49 in the same shape as the
2 lower insulator 49. The frit 48 serves to maintain the mesh grid 50 in position.

3 [0057] Through-holes 59 are also formed in the mesh grid 50. The spacer 43 of FIG. 4 is
4 inserted into the through-holes 59 and maintains a gap between the front substrate 41 and the rear
5 substrate 42.

6 [0058] FIG. 6 is a schematic partial exploded perspective view of the field emission display of
7 FIG. 4.

8 [0059] Referring to FIG. 6, the front substrate 41 is positioned in an upside-down state unlike
9 in FIG. 4. The front substrate 41 includes, on the inside thereof, the anode 53 and the phosphor
10 54, which form an illumination assembly. The illumination assembly is lighted by electrons
11 emitted from the electron emission assembly. As described above, the anode can be formed either
12 in a strip pattern or as a single layer formed over the whole inner surface of the front substrate.
13 In this case, it is preferable to form the phosphor 54 in a strip pattern perpendicular to the cathode.
14 The openings 56 corresponding to the phosphor 43 are formed in the mesh grid 50. The mesh grid
15 50 also has the through-holes 59 for the insertion of the spacer 43. As shown in FIG. 6, the spacer
16 43 comprises a horizontal portion 43a extended in the longitudinal direction of the anode 53 and
17 a vertical portion 43b extended perpendicularly to the horizontal portion 43a. The vertical portion
18 43b is inserted into the through-holes 59 of the mesh grid 50. Both ends of the vertical portion 43b
19 are contacted with the inner surfaces of the front substrate 41 and the rear substrate 42.
20 Accordingly, a gap between the two substrates is maintained.

21 [0060] FIG. 7 is a schematic flowchart of a process of manufacturing a field emission display

1 having the above-described structure. The process of manufacturing a field emission display will
2 now be described in detail with reference to FIGS. 4 through 7.

3 [0061] First, the cathode 55, the emitters 46, the insulator 45, and the gate 47 are formed on the
4 rear substrate 42 (step 71). The cathode, the emitters, the insulator, and the gate are formed in a
5 conventional method.

6 [0062] Next, the mesh grid 50 is formed (step 72). The mesh grid can be made of stainless steel
7 or invar as described above. The mesh grid is processed to a predetermined shape as described
8 above with reference to FIG. 5. The mesh grid can be made of an iron-nickel alloy to minimize
9 thermal expansion-related problems. Preferably, 2.0 to 10.0 wt% of chromium is added to the
10 iron-nickel alloy. Preferably, the thermal expansion coefficient of the mesh grid is in the range
11 of $9.0 \times 10^{-6}/^{\circ}\text{C}$ to $10.0 \times 10^{-6}/^{\circ}\text{C}$, which is more similar to the thermal expansion coefficient of the
12 substrate than that of invar, a conventional mesh grid material, i.e., about $1.2 \times 10^{-6}/^{\circ}\text{C}$. In
13 particular, the mesh grid 50 made of an iron-nickel alloy has a thermal expansion coefficient
14 similar to substrates made of a glass.

15 [0063] In more detail, the mesh grid 50 can be made of a iron-nickel alloy which contains 40.0
16 to 44.0 wt% of Ni, 49.38 to 53.38 wt% of Fe, 2.0 to 10.0 wt% of Cr, 0.2 to 0.4 wt% of Mn, 0.07
17 wt% or less of C, 0.3 wt% or less of Si, and an impurity.

18 [0064] Meanwhile, as shown in FIG. 6, the through-holes for insertion of the vertical portion
19 43b of the spacer 43 are formed in the mesh grid.

20 [0065] The mesh grid is subjected to pretreatment such as pre-firing to prevent the deformation
21 of the mesh grid in subsequent processes (step 73). An object of the pre-firing is to prevent the

1 generation of a residual stress during processing the mesh grid. The mesh grid with a residual
2 stress can be distorted in a subsequent firing process. During the pre-firing process, the mesh grid
3 50 is coated with an oxide film. The oxide film increases an adhesion between the mesh grid and
4 the insulators formed on the mesh grid. The pre-firing can be carried out at a temperature of 800
5 to 1,000°C.

6 [0066] Subsequent to the completion of the pre-firing, an insulating material is coated on the
7 upper and lower surfaces of the mesh grid using, for example, a thick film technology such as
8 screen printing. The coated insulating material can be fired at a temperature of 400 to 600°C and
9 crystallized to form the upper and lower insulators 49 and 51 (step 74).

10 [0067] The mesh grid having the insulators on the upper and lower surfaces thereof is arranged
11 on the rear substrate with respect to the emitters exposed through the openings of the gate. The
12 mesh grid is completely bonded to the rear substrate using the frit. The bonding of the mesh grid
13 to the rear substrate can be accomplished by firing the frit at a temperature of 400 to 500°C (step
14 75). In another embodiment, the mesh grid is not bonded using the frit. In other words, the mesh
15 grid can be supported above the electron emission assembly to maintain relative position thereto.

16 [0068] Next, the focusing electrode is formed on the upper surface of the upper insulator of the
17 mesh grid (step 76). The focusing electrode can be formed using an electrode material by thick
18 film technology such as screen printing, or thin film technology such as sputtering, chemical vapor
19 deposition, and an e-beam method.

20 [0069] Next, the spacer 43 is installed on the rear substrate (step 77). The spacer 43 is installed
21 to maintain a gap between the rear substrate 42 and the front substrate 41. The spacer 43 is

1 inserted into the through-holes 59 formed in the mesh grid 50.

2 [0070] Next, the front substrate 41 having the anode 53 and the phosphor 54 is joined to the rear
3 substrate 42 (step 78). The anode 53 and the phosphor 54 can be formed on the front substrate 41
4 using a conventional method. Even though not shown in drawings, a black matrix can be patterned
5 between the phosphor 54. The phosphor and the black matrix can be formed by electro-phoresis,
6 screen printing, or a slurry method. When the front substrate and the rear substrate are joined to
7 each other, an assembly can be fired at a temperature of 400 to 500°C (step 79). Accordingly, a
8 field emission display is obtained as a final product.

9 [0071] When the fabrication of a field emission display is completed, a voltage applied to the
10 mesh grid for optimal electron acceleration and a voltage applied to the focusing electrode for
11 optimal focusing are selected as follows.

12 [0072] First, a common voltage is applied to the gate and the anode. The voltage applied to the
13 gate is about 70 to 120 V and the voltage applied to the anode is about 1 kV or more. Then, a
14 voltage applied to the mesh grid is selected within a range of 30 to 300 V in order to find out an
15 optimal voltage condition for acceleration of electrons emitted from the emitter. Also, a voltage
16 applied to focusing electrode is selected within a range of -100 to 0 V in order to find out an
17 optimal voltage condition for focusing the accelerated electrons.

18 [0073] FIG. 8 is a schematic sectional view of a field emission display according to another
19 embodiment of the present invention.

20 [0074] Referring to FIG. 8, the field emission display of this embodiment has a structure similar
21 to that as shown in FIG. 4. The same constitutional elements have been represented by the same

1 reference numerals. The focusing electrode formed on the upper side of the mesh grid 50 is
2 omitted in the field emission display of FIG. 8.

3 [0075] As described above, the mesh grid 50 can be made of an iron-nickel alloy which contains
4 2.0 to 10.0 wt% of Cr. In more detail, the mesh grid 50 can be made of an iron-nickel alloy which
5 contains 40.0 to 44.0 wt% of Ni, 49.38 to 53.38 wt% of Fe, 2.0 to 10.0 wt% of Cr, 0.2 to 0.4 wt%
6 of Mn, 0.07 wt% or less of C, 0.3 wt% or less of Si, and an impurity. In this way, when the mesh
7 grid 50 is made of an iron-nickel alloy which contains chromium, the thermal expansion
8 coefficient of the mesh grid becomes approximate to those of the substrates. Therefore, a
9 mis-alignment between the mesh grid and the substrates can be prevented.

10 [0076] The present invention provides a field emission display including a mesh grid and a
11 focusing electrode that enable the prevention of display damage due to arcing and to acceleration
12 and focusing of emitted electrons. The mesh grid is formed in a space defined between a gate and
13 an anode so that electrons emitted from emitters pass through openings of the mesh grid
14 corresponding to the intersections of the anode and the cathode. Insulators are formed on the
15 upper and lower surfaces of the mesh grid. The mesh grid thus formed is fixed on the rear
16 substrate by a frit. Therefore, an adjustment of alignment between the mesh grid and the rear
17 substrate is simplified and a noise by vibration of the mesh grid that can be caused upon display
18 driving can be minimized. Also, arc-discharge is decreased, thereby enabling to application of a
19 high voltage. Even when an arc-discharge occurs, no damage to a cathode is caused. Furthermore,
20 the acceleration performance of emitted electrons is enhanced, thereby increasing the luminance
21 of the field emission display. Still furthermore, an e-beam can be focused by adjusting a voltage

1 applied to a focusing electrode, thereby producing a high luminance and high resolution field
2 emission display.

3 [0077] While the present invention has been particularly shown and described with reference
4 to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that
5 various changes in form and details can be made therein without departing from the spirit and
6 scope of the present invention as defined by the following claims.